



CONTINUING EDUCATION PROGRAM: FOCUS...

Ultrasound-guided injection in osteoarticular pathologies: General principles and precautions

H. Guerini^{a,*}, X. Ayral^b, V. Vuillemin^c, G. Morvan^c,
F. Thévenin^{a,c}, R. Campagna^a, J.-L. Drapé^a

^a *Hôpital Cochin, Radiology Department B, 27, rue du Faubourg-Saint-Jacques, 75014 Paris, France*

^b *Hôpital Cochin, Rheumatology Department B, 27, rue du Faubourg-Saint-Jacques, 75014 Paris, France*

^c *Imagerie médicale Léonard de Vinci, 43, rue Cortambert, 75015 Paris, France*

KEYWORDS

Ultrasonography;
Interventional;
Joint;
Tendon;
Injection

Abstract In the past, needle aspirations or injections involving the motor system were always carried out either blind or guided by fluoroscopy. Over the last few years, sonography has begun to offer an interesting alternative. Its advantages are that it is a relatively inexpensive technique, while not emitting ionising radiation and being easily accessible. There has been a great deal of technical progress including high frequency transducers, which have led to performance improvements in terms of both diagnosis and treatment of pathologies of the motor system. Due to these technical advances and to sterile covers for the transducers, it is now possible to visualise and to aspirate or inject into a peripheral joint, a tendon sheath or a bursa with or without effusion. This technique does not require a contrast medium injection because the needle position can be checked directly. Minimally invasive, it allows a number of interventions to be carried out with a very low complication rate since the entire path of the needle is followed using sonography, which means that nerves, vessels and other structures can be avoided because they are visualised directly in real time.

© 2012 Éditions françaises de radiologie. Published by Elsevier Masson SAS. All rights reserved.

For a long time, fluoroscopy-guided injections have been the only means of accurately injecting a substance into a joint or a tendon sheath. While joint injections are often carried out under fluoroscopy, injections to the soft tissue (bursa, tendon sheaths, peritendon) are for the main part carried out using standard injections. It is difficult to inject with certainty into a structure that is not seen directly via X-rays. It is of course possible to use an iodine-based contrast medium to check that the needle is in the right position, but this sometimes involves an extensive search within the tissue that needs to be crossed.

* Corresponding author.

E-mail address: henri.guerini@gmail.com (H. Guerini).

When we speak of ultrasound-guided techniques, this means procedures in which the needle is followed to its goal in real time and this does not include injections carried out by marking the skin of the area to be injected following an initial ultrasound. The difference is clear because this type of technique, a variation of a standard injection, does not use any of the features of ultrasound-guiding.

The advantages of ultrasound-guided injection are clear, given that it contributes to reducing risks and increases patient comfort:

- the needle reaches its goal directly, which reduces the risk of vascular or nerve puncture and the possibility of potentially harmful infiltrations directly into a damaged tendon [1,2];
- the absence of radiation;
- a reduced risk of allergies as there is no need for an iodine-based contrast medium.

If the necessity for routinely using image guidance for these injections is a subject for debate, then good sense and numerous studies should prompt us to do so [3–6]. Since a non-irradiating technique that carries minimal risks can be substituted (ALARA principle), this means that we can anticipate a growing role for ultrasonography in the treatment of musculoskeletal pathologies.

In this chapter, we discuss the basic principles of these injections, in the knowledge that while ultrasonography seems to be essential for injections into the periarticular soft tissue, it is also finding a place for itself in some joint injections.

Precautions to take before the injection

As with all injections, the patient must be informed about the procedure and their informed consent must be collected. It is of course essential to check that the patient is not allergic to the skin disinfectants or any of the products to be injected, in view of the fact that it is usually easy to find a substitute or to perhaps request specialised allergy tests. The patient must also be asked whether he/she is taking any antiaggregant or anticoagulant medication [7]:

- if the patient is taking vitamin K antagonists (VKA) [8]:
 - for intramuscular or deep injections (shoulder, hip, popliteal fossa): substitute heparin, which should itself be stopped 12 before the intervention and the patient should have an INR below 1.5 on the day before the procedure,
 - superficial ultrasound-guided injections can be carried out without interrupting VKA as long as the patient has an INR of between 2 and 3 on the day before the procedure (treatment may need to be adjusted);
- if the patient is taking platelet antiaggregants:
 - aspirin: no need to interrupt treatment at doses below 325 mg/day [9],
 - platelet antiaggregants such as clopidogrel (Plavix®, Clopilet®, Ceruvin®), ticlopidine clorhydrate (Ticlid®): the clinician responsible for this treatment should preferably be asked if it is possible to interrupt treatment at least five days before the intervention, as long as there is no significant risk that outweighs the expected benefits of the injection. This approach is

only justified when the patient is to have a deep injection (shoulder, hip, popliteal fossa);

- heparin (LMWH): do not take the last dose.

In all cases, the risks and benefits of stopping these treatments must be considered. The clinician should also find out whether the patient is diabetic or immuno-suppressed, and while these do not constitute absolute contraindications to the intervention, the risks and benefits should once again be carefully weighed up and care taken with aseptic technique. Similarly, if an injection is to take place close to a prosthesis then prior precautions should be taken in terms of ensuring that there is no underlying sepsis, and it is usual to consult the surgeon who inserted the prosthesis for an opinion. At the slightest suggestion of infection on the day of the injection, the intervention will need to be postponed. An injection of cortisone derivatives into a joint with a history of sepsis is contraindicated. Pregnancy is not a contraindication to a cortisone derivative injection. The best course of action is to obtain all of this information when the appointment for the intervention is being arranged, and a patient information leaflet and informed consent form need to be given to the patient at the same time for them to bring on the day of the procedure, completed and signed. This document will explain the risks that are common to all injection procedures and these will not be detailed in this article. Clinicians should ensure that the patient has understood the document before the procedure is carried out and provide further explanation if necessary. If high-level athletes are receiving a glucocorticosteroid injection, they have to make a declaration to the French antidoping agency (document available on the agency's website).

Diagnostic stage

Any ultrasound-guided injection will first include a diagnostic stage in order to confirm that the need for the injection is well founded and to prepare for the intervention. These ultrasound-guided injections do therefore require perfect mastery of bone and joint sonography. This diagnostic stage also allows for discussion with the patient and for questions to be repeated concerning any contraindications that the patient may have omitted to mention. This discussion can also be the time to provide additional information on how the intervention will proceed. If, after the diagnostic stage, the intervention seems not or no longer to be indicated, this must be explained to the patient and the clinician informed. Sometimes it leads to a slight change in the target of the injection, which should also be explained to the patient and the doctor requesting the intervention will possibly need to be consulted for an opinion.

Choice of transducer

The choice of transducer depends on the site to be injected. The transducer chosen for the injection will have the same frequency as that used for the diagnostic stage. In general, higher frequency transducers are used for the extremities. Some small joints or some tendon sheaths are easier to access using small L-shaped transducers (Fig. 1). Deeper

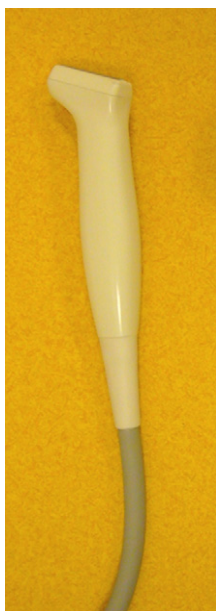


Figure 1. High frequency L-shaped transducer for injections in very peripheral sites.

injections will be carried out using a lower frequency transducer (Fig. 2).

Positioning the patient and preparing for the ultrasound

The patient must always be lying down in order not to fall if he/she begins to feel unwell. The side to be injected is normally next to the ultrasound system, which means that the patient's position may need to be adjusted (head at the top or bottom of the bed). The area to be injected must be



Figure 2. Array transducer with broad bandwidth for deeper injections.

at the same level as the operator's arm and the height of the bed may need to be adjusted depending on the injection.

We use a system that enables the transducer to be suspended above the site for injection (by means of a telescopic or articulated arm). Use of an articulated arm means that the operator can work with their hands free, by releasing the transducer which remains suspended above the site for injection. This means that a syringe or an injection product can be changed with no difficulty (Fig. 3). A foot-switch operated image capture system is also useful.

Aseptic technique

The assistance of another person may be useful in carrying out this intervention, but because of the articulated arm system, it is possible to carry out this procedure alone with a little training.

To start with, the transducer previously used for the diagnostic stage should be cleaned using a disinfectant wipe. Some ultraviolet disinfection systems can be used [10] but they complicate the intervention and do not guarantee that the transducer will be sterile, in which case a physical protective barrier consisting of an airtight sterile sheath is always required. Next, gel is applied to the transducer, which is still suspended from the articulated arm. It is important to begin by cleaning the skin following the technique of cleansing, rinsing, drying and using an antiseptic. Once the patient's skin is disinfected, the operator must wash their hands using a gentle soap and nail brush followed by disinfection with an alcohol-based hand gel, following the correct procedure for each product. Sterile gloves must also be used. We then open a kit containing the sterile covering for the transducer that includes a sterile drape, sterile gel, a sterile polyurethane sheath and elastic bands for attaching the transducer (Fig. 4). The sterile polyurethane sheaths are the same type as those used for covering transducers in the operating theatre. These sheaths have generally undergone a manufacturer's solidity test in order to guarantee resistance. The possibility of tiny perforations cannot, of course, be avoided entirely. These tiny perforations are mainly reported with latex condoms and in endorectal or endovaginal techniques [10]. The risk remains almost



Figure 3. Articulated arm allowing the transducer to remain covered and suspended above the patient.



Figure 4. Contents of a sterile kit (polyurethane sheath, sterile gel, elastic band).

non-existent for polyurethane sheaths bearing in mind that the literature essentially focuses on endoscopy transducers [11]. Once the sheath is placed on the transducer, the sterile gel is applied ready for the injection.

General rules

We could set out a number of general rules, but the one thing to remember above all is “use the conventional approaches”. Because of the freedom that ultrasonography offers in terms of views in a range of planes, this could lead operators to adjust their approach to each different situation. However, even if an injection can be adapted to suit a particular case, it is better to stick to approaches that are proven in terms of:

- an absence of risks to nerves and vasculature;
- the needle being clearly visualised in relation to its point of entry to the skin and the position of the transducer.

Marking the skin allows the landmarks to be easily located again after disinfection (Fig. 5). This is done while avoiding making a mark directly at the injection point. A point of entry to skin must be made that is away from the

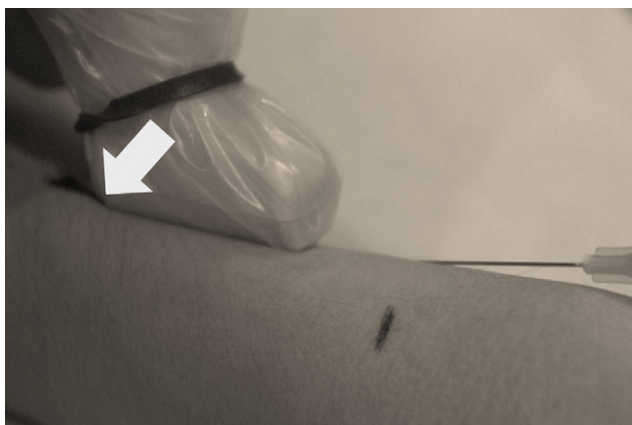


Figure 5. Marking the skin with the transducer end allowing the location and the direction to be reproduced after disinfection (arrow). Second marking away from and above the puncture site.

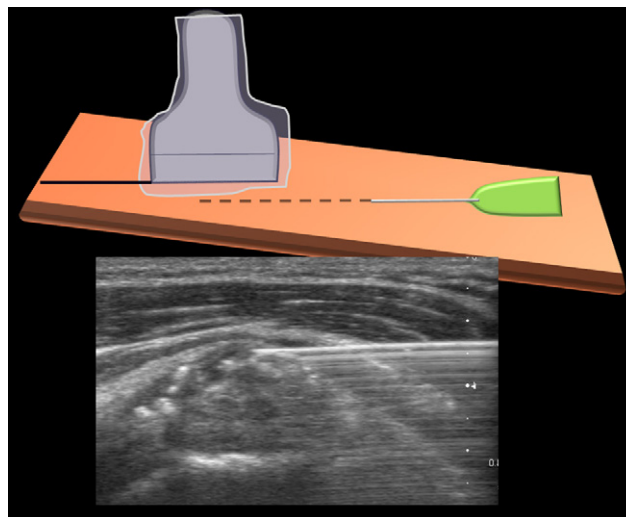


Figure 6. Simulation of a needle path parallel to the long axis of the transducer allowing the needle to be perfectly visualised.

ultrasound transducer in order to avoid any contact between the transducer and the needle. It is not always easy to see how this can be done, especially for small joints and tendon sheaths, in view of the prior precautions to take in covering the transducer with a sterile sheath and using sterile gel. In these cases, the needle should be introduced under the skin before the transducer is positioned nearby.

With regard to needle visibility, it is important to work out what path the needle will follow so that it remains as parallel as possible to the long axis of the transducer (Fig. 6). Indeed, if the needle's angle of incline increases in relation to the surface of the transducer it will be increasingly difficult to visualise. It is also advised that the needle should not be inserted with the transducer perpendicular to the long axis of the needle, because it will be impossible to visualise the entire needle in a single view during the procedure. It is also possible to angle the needle to make it more parallel to the transducer leading to easier insertion into tendon sheaths.

It is easy to check that fluid is diffusing into a tendon sheath, a bursa or a joint by observing the distribution of the local anaesthetic or, when the operator is certain the needle is in the correct position, this can be done by directly by observing distribution of the cortisone derivative. The criteria for success for a tendon sheath, bursa or joint are as follows:

- the fluid injected confirms a swelling in the cavity (Fig. 7);
- the product injected is seen to diffuse into the cavity, being visualised in Brownian motion (Fig. 8);
- gas bubbles that are often present in the syringe are visualised diffusing freely within the cavity or the tendon sheath injected (Fig. 9).

Injection of cortisone derivatives and viscosupplementation

Cortisone derivatives

Hydrocortancyl® (Prednisolone acetate), with its weak atrophying action, is especially indicated for peritendinous injections.

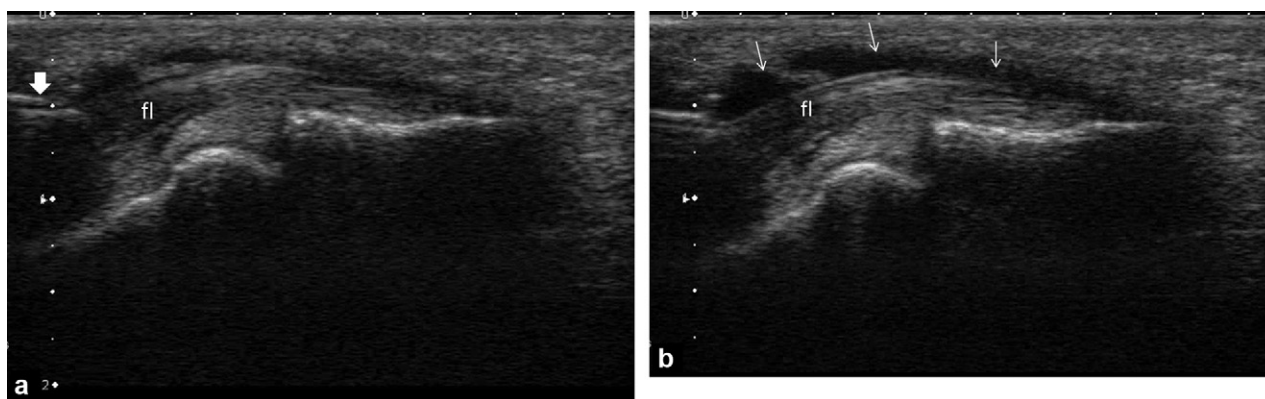


Figure 7. Distal longitudinal view of a flexor tendon of the finger. The needle is positioned within the thickened tendon (a). Dilatation of the sheath after injection (b).

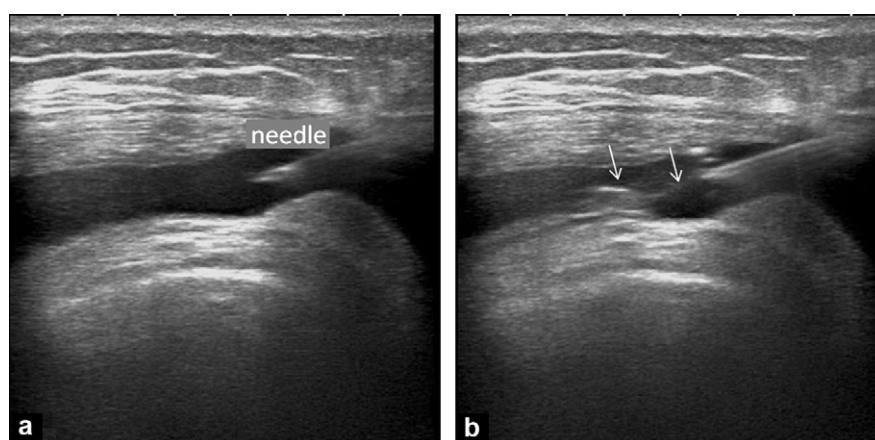


Figure 8. Axial view of the quadriceps tendon. Position of the transducer within the effusion (a). Injection confirmed to be successful by Brownian motion (b, arrows).

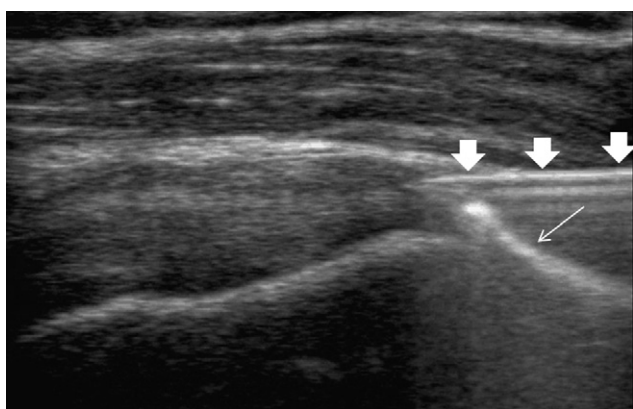


Figure 9. Coronal view of the supraspinatus tendon with a line of gas bubbles diffusing into the subacromial-deltoid bursa.

Altim® (cortivazol) and Diprostène® (Betamethasone acetate and phosphate) are commonly used in mechanical or inflammatory joint pathologies. These semi-delayed products have a relatively long action.

Hexatrione® (triamcinolone) is a specific type of delayed corticosteroid; it has a prolonged duration of action, as well as a very significant atrophying effect (achieved by destroying synovial tissue). It has turned out to perform better

than other corticosteroids, especially for the treatment of inflammatory types of arthritis, but the injection must be intra-articular, without raising pressure, given that extra-articular injections carry the risk of subcutaneous atrophy or secondary reflux. It is therefore formally contraindicated in periarticular pathologies. It is especially indicated for local treatment of inflammatory arthritis or crystal-induced arthritis. However, whether for mechanical or inflammatory pathologies, the effects of a corticosteroid injection are usually transient and require alternation with overall medical and/or physical management.

Viscosupplementation

Intra-articular injections of hyaluronic acid are offered as a second line therapy, after other medical treatments have failed, in painful cases of osteoarthritis with little or no effusion, that are moderate on radiology. Hyaluronic acid is an alternative to non-steroidal anti-inflammatory drugs when they are ineffective, poorly tolerated or contraindicated. Depending on the product and the joint affected, between one and three injections will be carried out at a rate of one a week. Hyaluronic acid is a local treatment with delayed and prolonged action. It is less effective than a corticosteroid injection for the first month postinjection, but more

effective after one month, with a more prolonged effect that can last between 6 and 12 months in favourable cases. This is not a treatment for osteoarthritis flare-ups, but a longer-term maintenance treatment. Hyaluronic acid injections can be preceded by a corticosteroid injection if there is joint effusion. These injections are usually carried out without support for the knee and with radiological guidance for other joints. Nonetheless, ultrasound-guiding is a suitable way to carry out a hyaluronic acid injection that is strictly intra-articular.

After the intervention

After all injections, the joint or limb concerned must be rested as far as possible for 48 hours. For some people, time off work will be considered and it is best prescribed by the doctor who ordered the intervention. Some teams recommend immobilising the injected site for 48 hours with a splint. Naturally, care after these injections must include the usual steps for the treatment of rheumatic or mechanical pathologies (physiotherapy, immobilisation, systemic treatments). In principle, the patient should contact a doctor (preferably the same one who carried out the procedure) if they experience any complications in the days after the injection. In addition to the risk of sepsis (arthritis, cellulitis, infectious tenosynovitis), aseptic (chemical) arthritis that resolves spontaneously and certain systemic effects linked to cortisone derivatives can arise in the days following these injections [12].

Conclusion

Ultrasound-guidance of injections leads to almost optimum precision and safety without the use of ionising radiation or the risk of allergy to iodine-based contrast media. A diagnostic ultrasound precedes the intervention and requires the operator to have a perfect understanding of the anatomy and the disease. If aseptic conditions and approaches are followed, this technique will hold an increasingly important role in the arsenal of treatments for osteoarticular disease as long as a suitable nomenclature comes to light.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References

- [1] Ferland MA, Uhthoff HK. Localized necrosis due to intratendinous injection of glucocorticoids: comparative experimental study. *Union Med Can* 1972;101:1768–71.
- [2] McWhorter JW, Francis RS, Heckmann RA. Influence of local steroid injections on traumatized tendon properties. A biomechanical and histological study. *Am J Sports Med* 1991;19:435–9.
- [3] Hashiuchi T, Sakurai G, Morimoto M, Komei T, Takakura Y, Tanaka Y. Accuracy of the biceps tendon sheath injection: ultrasound-guided or unguided injection? A randomized controlled trial. *J Shoulder Elbow Surg* 2011;20:1069–73.
- [4] Naredo E, Cabero F, Beneyto P, Cruz A, Mondéjar B, Uson J, et al. A randomized comparative study of short term response to blind injection versus sonographic-guided injection of local corticosteroids in patients with painful shoulder. *J Rheumatol* 2004;31:308–14.
- [5] Peck E, Lai JK, Pawlina W, Smith J. Accuracy of ultrasound-guided versus palpation-guided acromioclavicular joint injections: a cadaveric study. *PMR* 2010;2:817–21.
- [6] Soh E, Li W, Ong KO, Chen W, Bautista D. Image-guided versus blind corticosteroid injections in adults with shoulder pain: a systematic review. *BMC Musculoskelet Disord* 2011;12:137.
- [7] Potet J, Weber-Donat G, Thome A, Valbousquet L, Peroux E, Konopacki J, et al. Prise en charge du risque hémorragique au cours des actes de radiologie interventionnelle. *J Radiol* 2011;92:659–70.
- [8] HAS. Prise en charge des surdosages en antivitamines K, des situations à risque hémorragique et des accidents hémorragiques chez les patients traités par antivitamines K en ville et en milieu hospitalier 2008.
- [9] Horlocker TT, Bajwa ZH, Ashraf Z, Khan S, Wilson JL, Sami N, et al. Risk assessment of hemorrhagic complications associated with nonsteroidal antiinflammatory medications in ambulatory pain clinic patients undergoing epidural steroid injection. *Anesth Analg* 2002;95(6):1691–7.
- [10] Kac G, Podglajen I, Si-Mohamed A, Rodi A, Grataloup C, Meyer G. Evaluation of ultraviolet C for disinfection of endocavitary ultrasound transducers persistently contaminated despite probe covers. *Infect Control Hosp Epidemiol* 2010;31:165–70.
- [11] Alvarado CJ, Anderson AG, Maki DG. Microbiologic assessment of disposable sterile endoscopic sheaths to replace high-level disinfection in reprocessing: a prospective clinical trial with nasopharyngoscopes. *Am J Infect Control* 2009;37:408–13.
- [12] Cohen M, Jacob D. L'échographie interventionnelle. *J Radiol* 2007;88:1223–9.